PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

2 4 JUN 2005

Applicant's or agent's file reference V474.PC.3	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IB 03/06141	International filing date *(day/month/year)* 17.12.2003	Priority date *(day/month/year)* 30.12.2002

International Patent Classification (IPC) or both national classification and IPC

H04N7/50

Applicant

VISIOWAVE S.A.

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1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

    ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

    These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

    I   ☒ Basis of the opinion
    II   ☐ Priority
    III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
    IV   ☐ Lack of unity of invention
    V   ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
    VI   ☐ Certain documents cited
    VII ☐ Certain defects in the international application
    VIII ☐ Certain observations on the international application

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Date of submission of the demand 12.05.2004	Date of completion of this report 04.04.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized Officer Sampels, M Telephone No. +49 30 25901-420

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.   PCT/IB 03/06141

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

    Description, Pages

    1-10   as originally filed

    Claims, Numbers

    1-10   received on 28.02.2005 with letter of 23.02.2005

    Drawings, Sheets

    1/4-4/4   as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

    These elements were available or furnished to this Authority in the following language: , which is:

    ☐   the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

    ☐   the language of publication of the international application (under Rule 48.3(b)).

    ☐   the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

    ☐   contained in the international application in written form.

    ☐   filed together with the international application in computer readable form.

    ☐   furnished subsequently to this Authority in written form.

    ☐   furnished subsequently to this Authority in computer readable form.

    ☐   The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

    ☐   The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

    ☐   the description,   pages:

    ☐   the claims,   Nos.:

    ☐   the drawings,   sheets:

Form PCT/IPEA/409 (January 2004)

5. ☒   This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-10
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-10
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-10
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item I
Basis of the report

The amendments filed with the letter dated 23.02.2005 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following: The formulas given in claim 9 and claim 10 are not present in the application as filed. An addition of a normalization factor (claim 9) and the inversion of an exponent (claim 10) is not considered an obvious correction to the disclosure of the description (see page 4, lines 1-7 of the description). According to Rule 70.2(c), claims 9 and 10 are examined as if the formulas of claim 9 and claim 10 of the application as originally filed were present.

Re Item V
Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: MOSCHETTI F, GRANAI L, VANDERGHEYNST P, FROSSARD P: "New dictionary and fast atom searching method for matching pursuit representation of displaced frame difference" PROCEEDINGS OF THE 2002 IEEE INTERNATIONAL CONFERENCE ON IMAGE PROCESSING (ICIP 2002), vol. 3, 22 September 2002 (2002-09-22), - 25 September 2002 (2002-09-25) pages 685-688, XP002241660 Rochester, New York, US

D2: NEFF R, ZAKHOR A: "VERY LOW BIT-RATE VIDEO CODING BASED ON MATCHING PURSUITS" IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE INC. NEW YORK, US, vol. 7, no. 1, 1 February 1997 (1997-02-01), pages 158-171, XP000678888 ISSN: 1051-8215

D3: VANDERGHEYNST P, FROSSARD P: "Efficient image representation by anisotropic refinement in matching pursuit" PROCEEDINGS OF THE 2001 IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING (ICASSP '01), vol. 3, 7 May 2001 (2001-05-07), - 11 May 2001 (2001-05-11) pages 1757-1760, XP002241661 Salt Lake City, Utah, US

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows a video coding method (see D1: page 685, left column, line 19) of exploiting the temporal redundancy between successive frames in a video sequence (see D1: page 685, left column, lines 20-22) where

- a reference frame is first approximated by a collection of basis function and that the atoms are sent to a decoder (see D1: page 685, right column, equation (3); page 686, left column, lines 10-21; it is implicit with a video coding method that coded data is sent to a decoder),

- the parameters of the geometric transformation are sent to a decoder in order to reconstruct the predicted frames (this is implicit with a video coding method as disclosed in D1).

The subject-matter of claim 1 differs from this known video coding method in that

- as alternative to the approximation by basis function the I-frame may be encoded by any frame codec,

- the predicted frames are approximated by the geometric transformations of the basis functions describing the previous frame (this is different from the closest prior art, where the following predicted frames are represented as a displaced frame difference that is approximated by the geometric transformations of the basis functions describing the previous frame (see D1: page 686, left column, lines 22-24)).

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to avoid the classical block based primitives in the prediction scheme of an atoms-based video encoding method.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:
The use of the basis functions describing the previous frame is mentioned in the prior art documents D1-D3 only in the context of the approximation of a first frame (I-frame) or the

approximation of a motion compensated difference frame. A direct approximation of the predicted frames is neither disclosed nor obvious.

Claims 2-10 (see above remark concerning claims 9 and 10) are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Industrial applicability of a video coding method is clearly given, for example in digital cameras. The claims 1-10 (see above remark concerning claims 9 and 10) thus are in accordance with Article 33(4) PCT.

CLAIMS

1. Video coding method of exploiting the temporal redundancy between successive frames in a video sequence **characterized in that** a reference frame, called I-frame, is first approximated by a collection of basis function, called atoms, and that either the atoms are quantized, entropy coded and sent to a decoder or that the original I-frame is encoded and transmitted to the decoder using any frame codec, and that the following predicted frames called, P-frames, are approximated by the geometric transformations of the basis functions (atoms) describing the previous frame, and that the parameters of the geometric transformation are quantized, entropy coded and sent to a decoder in order to reconstruct the predicted frames.

2. Video coding method according to claim 1, **characterized in that** the I-frame is approximated by a linear combination of N atoms $g_{\gamma_n}(x,y)$:

$$I(x,y) = \sum_{n=0}^{N-1} c_n g_{\gamma_n}(x,y),$$ selected in a redundant, structured library and indexed by a string of parameters γ_n representing the geometric transformations applied to the generating mother function $g(x,y)$ and the c_n are weighting coefficients.

3. Video coding method according to claim 2, **characterized in that** the atoms occurring in the decomposition are chosen using the Matching Pursuit algorithm.

4. Video coding method according to one of the claims 1 to 3, **characterized in that** the parameters and coefficients of the atoms are quantized and entropy coded.

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5. Video coding method according the claims 4, **characterized in that the** quantization of the parameters and the coefficients can vary across time, and that the variation is controlled by a rate control unit.

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6. Video coding method according to one of the claims 1 to 5, **characterized in that** the method is used together with a residual frame based texture codec that encodes the differences between the original frames and the ones reconstructed using the compensated atoms.

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7. Video coding method according to one of the claims 1 to 6, **characterized in that** the geometric features (atoms) of the I-frame are computed from the quantized frames at the encoder and decoder and are not transmitted.

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8. Video coding method according to one of the claims 1 to 7, **characterized in that** the geometric features (atoms) are re-computed after each quantized frame at the encoder and decoder and replace the previous prediction.

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9. Video coding method according to one of the claims 1 to 8, **characterized in that** the geometric transformations used to build the library are composed of translations, anisotropic dilations and rotations, applied to a generating mother function $g(x,y)$ by means of the following change of variables:

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$$g_r(x,y) = \frac{1}{\sqrt{a_1 a_2}} g(x_n, y_n), \text{ where}$$

$$x_n = \frac{\cos\vartheta(x-b_1) - \sin\vartheta(y-b_2)}{a_1}$$

$$y_n = \frac{\sin\vartheta(x-b_1) + \cos\vartheta(y-b_2)}{a_2}$$

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10. Video coding method according to one of the claims 1 to 9, **characterized in that** the generating mother function is of the following form:

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$$g(x,y)=(1-x^2)\exp\left(-\frac{x^2+y^2}{2}\right).$$

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